



# TWO-WAY TABLES — WALKING AND BICYCLING TO WORK

## Student Learning Objectives

- I will be able to interpret two-way tables containing data on two categorical variables collected from the same subjects.
- I will be able to describe possible associations between two categorical variables by calculating relative frequencies and conditional relative frequencies.

## Part 1 – Make Data Observations

Cambridge, Massachusetts, and Columbia, South Carolina, are among the cities that had the highest rates of workers walking to work in 2019. Walking and biking are the two modes of nonmotorized transportation that the U.S. Census Bureau counts in its American Community Survey (ACS).

The ACS is conducted monthly by the Census Bureau and is designed to show how communities are changing. Through asking questions of a sample of the population, it produces national data on more than 35 categories of information, such as education, income, housing, and employment.

In this activity, you will use two-way tables to compare ACS data for three categorical variables:

- **City:** Cambridge and Columbia
- **Mode of transportation:** walking and biking
- **Gender:** men and women

NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

1. Examine Tables 1 and 2 below and write down your observations and questions about the data. These data show workers aged 16 and older — in Cambridge and in Columbia — who walked or biked to work in 2019.

Table 1

Cambridge, Massachusetts	Walked	Biked	Total
Men	8,981	4,471	13,452
Women	7,809	1,753	9,562
Total	16,790	6,224	23,014

Table 2

Columbia, South Carolina	Walked	Biked	Total
Men	9,998	344	10,342
Women	6,155	118	6,273
Total	16,153	462	16,615

## Part 2 – Calculate Relative Frequencies

Calculate the relative frequencies for Tables 1 and 2 by dividing the value in each cell by the total for that table. (For example, to calculate the relative frequency of men in Cambridge who walked to work, divide 8,981 by 23,014. You should get a decimal between 0 and 1 that, after moving the decimal point to the right two places, represents the proportion of men in Cambridge who walked to work.) Round your numbers to the nearest whole percentage and place them in Tables 3 and 4.

### Table 3

Cambridge, Massachusetts	Walked	Biked	Total
Men			
Women			
Total			100%

### Table 4

Columbia, South Carolina	Walked	Biked	Total
Men			
Women			
Total			100%

1. Why is it that both numbers in the “Total” cells for Tables 3 and 4 equal 100 percent?
2. Which city had a greater number of workers who walked to work (of the workers who use nonmotorized transportation to get to work)?

3. Which city had a greater proportion of workers who walked to work (of the workers who use nonmotorized transportation to get to work)?
4. Do you see any differences in the proportions of men and women who bike or walk to work, out of those that use nonmotorized transportation to get to work? Do you see any differences between the data for the two cities? Explain, citing the data.

### Part 3 - Calculate Conditional Relative Frequencies by Row

Sometimes it is necessary to examine only one row in a data set. For example, to determine what percentage of women in Cambridge walked to work and what percentage biked, you could divide the value in each corresponding cell of Table 1 by the total for that row.

In Table 5 below, the relative frequencies by row for Cambridge have been calculated from Table 1 and written as percentages, each rounded to the nearest whole percentage. Using the data from Table 2, calculate the percentages for Columbia and record them in Table 6, following the same format.

Table 5

Cambridge, Massachusetts	Walked	Biked	Total
Men	67%	33%	100%
Women	82%	18%	100%
Men and Women	73%	27%	100%

Table 6

Columbia, South Carolina	Walked	Biked	Total
Men			
Women			
Men and Women			100%

1. Why are all the values in the “Total” column equal to 100 percent?
2. Of the women in Cambridge who used nonmotorized transportation to get to work, what percentage walked and what percentage biked?
3. Of the women in Columbia who used nonmotorized transportation to get to work, what percentage biked?
4. Of the men in Cambridge who used nonmotorized transportation to get to work, what percentage biked?
5. Of both the men and the women in Cambridge who used nonmotorized transportation to get to work, what percentage walked?

## Part 4 – Calculate Conditional Relative Frequencies by Column

Sometimes it is necessary to examine only one column from a data set. For example, to determine the percentage of workers who biked to work and who are women — as opposed to the percentage of all female nonmotorized commuters who biked to work — you could divide the value in the center cell of Tables 1 and 2 by the total for that column.

In Table 7 below, the relative frequencies by column for Cambridge have been calculated from Table 1 and written as percentages, each rounded to the nearest whole percentage. Using the data from Table 2, calculate the relative frequencies by column for Columbia and record them in Table 8, following the same format.

Table 7

Cambridge, Massachusetts	Walked	Biked	Total
Men	53%	72%	58%
Women	47%	28%	42%
Total	100%	100%	100%

Table 8

Cambridge, Massachusetts	Walked	Biked	Total
Men			
Women			
Total			100%

1. Why are all the values in the “Total” row equal to 100 percent?
2. Of all workers in Cambridge who used nonmotorized transportation to get to work, what percentage of those who biked were women?
3. Of all workers in Cambridge who used nonmotorized transportation to get to work, what percentage of those who biked were men?

4. Calculate the difference in percentage points between the percentage of men and the percentage of women in Cambridge who biked to work:
5. Of the Columbia workers who used nonmotorized transportation, what percentage of those who biked were women?
6. Of the Columbia workers who used nonmotorized transportation, what percentage of those who biked were men?
7. Calculate the difference in percentage points between the percentage of men and the percentage of women in Columbia who biked to work:
8. What are some other questions you could answer with these data, using any of the two-way tables? Write three questions and answer them.
  - a.
  - b.
  - c.

## Part 5 – Draw Conclusions

Write a three-paragraph news article — with a headline — that summarizes what you have learned. Think about one overarching idea that compares the two cities, the two genders, or the two modes of transportation.

In the first paragraph, write your overarching idea as a thesis statement, supporting it with specific data. Be sure to use appropriate mathematical language. In the second paragraph, explain why you think your thesis statement is true based on your general knowledge of these two cities, possible preferences of the genders, or the modes of transportation. In the third paragraph, restate your thesis and summarize your supporting points.